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CLAIMS

1. Automated method for discriminating the cardiac beat, on the basis of a blood pressure sampled signal, having a starting point P_{start} , characterised in that it operates according to a finite state machine, comprising:

A. a first state (1), wherein the method searches for:

- the pressure absolute minimum value P_{min} , by scanning the pressure values included within a first time interval not exceeding the interval going from the starting point P_{start} up to the point distant from the determined minimum value P_{min} by a first time threshold $DTMIN_SYS$,

- the pressure absolute maximum value P_{max} , by scanning the pressure values included within a second time interval not exceeding the interval going from the starting point P_{start} up to the point distant from the determined minimum value P_{min} by a second time threshold $DTMAX_SYS$, and

- the pressure signal first derivative maximum value $Y1_{max_postdia}$ included within a third time threshold not exceeding the interval going from the starting point P_{start} up to the point distant from the determined minimum value P_{min} by a period equal to the second time threshold $DTMAX_SYS$,

the method assuming the point P_{min} as diastolic point P_{dia} and the point P_{max} as systolic point P_{sys} , and passing to a following second state (2);

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- B. the second state (2), wherein the method searches for a pressure signal inflection point $P_{inflection}$ following the systolic point P_{sys} in a fifth time interval not exceeding the interval starting from the systolic point P_{sys} and of duration equal to a third time threshold $DTMAX_MINY1_SYS$, the method then passing to a following third state (3);
- C. the third state (3), wherein the method verifies whether, in a sixth time interval not exceeding the interval starting from the inflection point $P_{inflection}$ and of duration equal to a fourth time threshold $DTMAX_SYS2Y1DIC$, the pressure signal presents a hump with downward concavity, so that:
- if the outcome of the verification is positive, the method searches, in a seventh time interval not exceeding the interval starting from the inflection point $P_{inflection}$ and of duration equal to the fourth time threshold $DTMAX_SYS2Y1DIC$, for the first pressure curve relative minimum, and it assumes the latter as dicrotic point P_{dic} , whereas
 - if the outcome of the verification is negative, the method searches in said seventh time interval the instant wherein the pressure signal second derivative assumes the maximum value $Y2max_postinflection$, and it assumes the related pressure signal point as dicrotic point P_{dic} ,
- the method then passing to a following fourth state (4);
- D. the fourth state (4), wherein the method searches for a maximum

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value $Y1_{max_postdic}$ of the pressure signal first derivative in an eighth interval not exceeding the interval starting from the dicrotic point P_{dic} and of duration equal to a fifth time threshold $DPOSTDIC$, the method verifying that the maximum value

5 $Y1_{max_postdia}$ determined in the first state (1) is not less than the value $Y1_{max_postdic}$, so that:

- if the outcome of the verification is negative, the method returns to the first state (1) assuming as new starting point P_{start} a point following the diastolic point P_{dia} and not following the
- 10 dicrotic point P_{dic} , whereas
- if the outcome of the verification is positive, the method passes to a final state (7); and

E. the final state (7), wherein the method is apt to give the diastolic point P_{dia} , the systolic point P_{sys} , and the dicrotic point P_{dic} .

15 2. Method according to claim 1, characterised in that in the first state (1) it also searches for:

- the pressure signal second derivative maximum value $Y2_{max_diatosys}$ included within a fourth time interval not exceeding the interval going from the starting point P_{start} up to the
- 20 point distant from the determined minimum value P_{min} by a period equal to the second time threshold $DTMAX_SYS$,

and in that in the fourth state (4) it also searches for a pressure signal second derivative maximum value $Y2_{max_postdic}$ within the eighth interval, the method also verifying that the maximum value

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Y2max_diatosys determined in the first state (1) is not less than the value Y2max_postdic, so that:

- if the outcome of the verification is negative, the method returns to the first state (1) assuming as new starting point Pstart a point following the diastolic point Pdia and not following the dicrotic point Pdic, whereas
- if the outcome of the verification is positive, the method passes to the final state (7).

3. Method according to claim 1 or 2, characterised in that in the first state (1), the assumption of the points Pmin and Pmax as diastolic Pdia and systolic Psys points, respectively, depends on the outcome of the verification that the point Pmin precedes the point Pmax, so that:

- if the outcome of the verification is negative, the method returns to perform all the operations of the first state (1) assuming as new starting point Pstart a point not preceding Pmin, whereas
- if the outcome of the verification is positive, the point Pmin is assumed as diastolic point Pdia and the point Pmax is assumed as systolic point Psys and the method passes to the following second state (2).

4. Method according to any one of the preceding claims, characterised in that the finite state machine according to which it operates comprises a fifth state (5), the method passing from the fourth state (4) to the final state (7) by preliminarily passing to the fifth state (5),

wherein the method determines a pressure signal point P3 corresponding to the instant t3 wherein the pressure signal second derivative assumes the absolute minimum value Y2min_systodic within a ninth interval not exceeding the interval going from the systolic point Psys up to the dicrotic point Pdic, the method then passing to the final state (7) wherein it is apt to give the point P3.

5. Method according to claim 4, characterised in that said ninth interval goes from the instant which is intermediate within the interval included between the systolic point P_{sys} and the diastolic point P_{dic}

10 $t_{\text{sys}} + (t_{\text{dic}} - t_{\text{sys}})/2$

up to the instant of the dicrotic point P_{dic}

 tdic, |

where t_{sys} is the instant corresponding to the systolic point P_{sys} and t_{dic} is the instant corresponding to the diastolic point P_{dic} .

15 6. Method according to claim 4 or 5, characterised in that in the fourth state (4) the method verifies whether the pressure signal has been detected in an aorta, so that:

- if the outcome of the verification is positive, the method passes to the final state (7), whereas
- 20 - if the outcome of the verification is negative, the method passes to the fifth state (5).

7. Method according to any one of the preceding claims, characterised in that the finite state machine according to which it operates comprises a sixth state (6), at which the method arrives in the case

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when in the third state (3) it has verified that the pressure signal presents a hump with downward concavity within the sixth time interval, the method arriving at the sixth state (6) after the fourth state (4) before passing to the final state (7), in the sixth state (6) the method searching
5 in said sixth time interval for the relative maximum point P4 after the dicrotic point Pdic, i.e. the hump apex, the method then passing to the final state (7) wherein it is apt to give the point P4.

8. Method according to claim 7, characterised in that in the sixth state (6) the method also searches for a pressure signal relative
10 minimum point Pend within a tenth interval not exceeding the interval going from the dicrotic point Pdic up to the point Ptermination distant from the dicrotic point Pdic by a sixth time threshold DENDPOSTDIC, the method being apt to give in the final state (7) the point Pend in the case when this has been determined in the sixth state (6).

15 9. Method according to claim 8, characterised in that the method searches for the point Pend after having determined the point P4 and in that said tenth interval goes from the point P4 up to the point Ptermination.

10. Method according to claim 8 or 9, characterised in that the
20 sixth time threshold DENDPOSTDIC is not longer than 150 milliseconds.

11. Method according to any one of the claims from 7 to 10, when dependant upon claim 4, characterised in that the method arrives at the sixth state (6) starting from the fifth state (5).

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12. Method according to any one of the preceding claims, characterised in that in the first state (1) it searches for the first point P_{dec} following the starting point P_{start} belonging to a pressure signal decreasing phase, in that the first time interval goes from the first decreasing point P_{dec} up to the point distant from the determined minimum value P_{min} by a first time threshold $DTMIN_SYS$, and in that the second time interval goes from the first decreasing point P_{dec} up to the point distant from the determined minimum value P_{min} by a second time threshold $DTMAX_SYS$.

13. Method according to claim 12, characterised in that the third and the four time intervals go from the first decreasing point P_{dec} up to the point distant from the determined minimum value P_{min} by a second time threshold $DTMAX_SYS$.

14. Method according to any one of the claims from 1 to 12, characterised in that the third and the four time intervals go from the determined minimum value P_{min} up to the point distant from the determined minimum value P_{min} by a second time threshold $DTMAX_SYS$.

15. Method according to any one of the claims from 1 to 12, characterised in that the third and the four time intervals go from the determined minimum value P_{min} up to the determined maximum value P_{max} .

16. Method according to any one of the preceding claims, characterised in that in the second state (2) it searches for the point $P_{inflection}$ by searching for the pressure signal first derivative absolute

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minimum value $Y1_{min_postsys}$ within the fifth time interval, assuming the pressure signal point wherein the first derivative thereof assumes the absolute minimum value $Y1_{min_postsys}$ as inflection point $P_{inflection}$.

5 17. Method according to any one of the preceding claims, characterised in that in the third state (3) it verifies whether in the sixth time interval the pressure signal presents a hump with downward concavity by searching for the pressure signal first derivative absolute maximum value $Y1_{max_postsys}$ and by verifying that this value $Y1_{max_postsys}$ is
10 positive, whereby the pressure signal presents said hump in the case when the value $Y1_{max_postsys}$ is positive.

 18. Method according to any one of the preceding claims, characterised in that in the third state (3) it searches within the seventh time interval for the pressure curve first relative minimum by searching for
15 the instant wherein the pressure signal first derivative assumes the value of zero within said seventh time interval.

 19. Method according to any one of the preceding claims, characterised in that, in the fourth state (4), the search for the first derivative maximum value $Y1_{max_postdic}$ and the second derivative maximum value $Y2_{max_postdic}$ of the pressure signal within the eighth interval, and the verification that both are not larger than the maximum values $Y1_{max_postdia}$ and $Y2_{max_diatosys}$ determined in the first
20 state (1), are carried out only in the case when in the third state (3) the method has verified that the pressure signal presents a hump with

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downward concavity within the sixth time interval.

20. Method according to any one of the preceding claims, characterised in that, when it returns from the fourth state (4) to the first state (1), the method assumes the point immediately preceding the determined dicrotic point P_{dic} as new starting point P_{start} .

21. Method according to any one of the preceding claims, characterised in that the first time threshold $DTMIN_SYS$ is not longer than 200 milliseconds.

22. Method according to claim 21, characterised in that the first time threshold $DTMIN_SYS$ is not longer than 150 milliseconds.

23. Method according to any one of the preceding claims, characterised in that the second time threshold $DTMAX_SYS$ is not longer than 380 milliseconds.

24. Method according to claim 23, characterised in that the second time threshold $DTMAX_SYS$ is not longer than 350 milliseconds.

25. Method according to any one of the preceding claims, characterised in that the third time threshold $DTMAX_MINY1_SYS$ is not longer than 250 milliseconds.

26. Method according to claim 25, characterised in that the third time threshold $DTMAX_MINY1_SYS$ is not longer than 200 milliseconds.

27. Method according to any one of the preceding claims, characterised in that the fourth time threshold $DTMAX_SYS2Y1DIC$ is not

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longer than 250 milliseconds.

28. Method according to claim 27, characterised in that the fourth time threshold DTMAX_SYS2Y1DIC is not longer than 200 milliseconds.

5 29. Method according to any one of the preceding claims, characterised in that the fifth time threshold DPOSTDIC is not longer than 200 milliseconds.

30. Method according to claim 29, characterised in that the fifth time threshold DPOSTDIC is not longer than 150 milliseconds.

10 31. Method according to any one of the preceding claims, characterised in that the pressure signal is sampled at a frequency of 1 kHz.

32. Method according to any one of the claims from 1 a 10, characterised in that from the final state (7) it returns to iteratively perform the first state (1) by assuming a point following the dicrotic point Pdic as new starting point Pstart.

33. Method according to claim 32, when depending upon any one of claims from 1 to 7, characterised in that from the final state (7) it returns to iteratively perform the first state (1) by assuming a point following the dicrotic point Pdic and distant from this by a seventh time threshold DNEW as new starting point Pstart.

34. Method according to claim 33, characterised in that the seventh time threshold DNEW is not shorter than 1 millisecond and not longer than 150 milliseconds.

35. Method according to claim 32, when depending upon any one of claims from 8 to 10, characterised in that, in the case when in the sixth state (6) the point P_{end} has been determined, from the final state (7) the method returns to iteratively perform the first state (1) by
5 assuming a point following the dicrotic point P_{dic} and preceding the point P_{end} as new starting point P_{start} .

36. Method according to claim 35, characterised in that, in the case when in the sixth state (6) the point P_{end} has been determined, from the final state (7) the method returns to iteratively perform the first
10 state (1) by assuming the point immediately preceding the point P_{end} as new starting point P_{start} .

37. Method according to claim 32, when depending upon any one of claims from 8 to 10, characterised in that, in the case when in the sixth state (6) the point P_{end} has not been determined, from the final
15 state (7) the method returns to iteratively perform the first state (1) by assuming a point following the dicrotic point P_{dic} and not following the point $P_{termination}$ as new starting point P_{start} .

38. Method according to claim 37, characterised in that, in the case when in the sixth state (6) the point P_{end} has not been determined, from the final state (7) the method returns to iteratively perform
20 the first state (1) by assuming the point immediately preceding the point $P_{termination}$ as new starting point P_{start} .

39. Computer, comprising input and/or output interface means, memorising means, and processing means, characterised in that it is apt

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to perform the automated method for discriminating the cardiac beat according to any one of the preceding claims 1-38.

40. Apparatus for detecting and analysing the blood pressure, comprising a computer and blood pressure detecting means, characterised in that said computer is the computer according to claim 39.

41. Computer program characterised in that it comprises code means adapted to execute, when running on a computer, the automated method for discriminating the cardiac beat according to any one of the preceding claims 1-38.

42. Memory medium, readable by a computer, storing a program, characterised in that the program is the computer program according to claim 41.